



Forecasts of Production, Consumption, and the Trade Balance of Primary Energy and Fuels in the USA

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Abstrakt

The article analyzes various forecasts of production, consumption, and the trade balance of primary energy and secondary fuels first of all in the United States and partly in Canada. The combined analysis of the US in Canadian economies is well-founded as these economies are closely related. However, the main emphasis was on US economy. The analysis covers different scenarios of fuel and energy demand, including the currently implemented baseline scenario, the new policies scenario, assuming that countries comply with the emission limits set at the COP21 in Paris, and the environmental scenario, the strictest from the point of view of environmental protection, aimed at restricting global warming to less than 2°C above pre-industrial temperatures. The analyzed values are different for different scenarios, as shown in the figures. Most attention was paid to fossil fuels, that is, oil, natural gas, bituminous coal, and lignite. The forecasts of production, consumption, and import of individual carriers are presented. It was shown that the United States policy places greatest emphasis on the energy security and self-sufficiency. As of today, the United States is one of the most hydrocarbon-rich countries, while low electricity prices are the reason why American products are competitive compared to products from the European Union and China. Reducing the use of coal in the U.S. economy in favor of renewable energy sources will result in an oversupply of this raw material in the international markets, which, in turn, will lead to a decrease in prices. The increasing production of oil and gas will have a similar effect.

Keywords: forecasts, production, consumption, primary energy, secondary fuels

Introduction

Primary energy is obtained directly from natural resources. The primary energy carriers are fossil fuels such as bituminous coal, lignite, oil, natural gas, and renewable energy sources, i.e. wind power, solar power, hydropower, biomass or geothermal energy.

The United States is one of the few countries where energy resources are found in great abundance. As of the end of 2017, the United States has 48 billion tons of crude oil, which represents 2.8% of the world's resources. In addition, 8.7 billion of cubic meters of natural gas and 252 billion tons of coal account for 4.7% and 22.1% of world resources, respectively. Canada has 27.6 billion tons of oil (10.0% of world resources), 2.2 billion of cubic meters of natural gas (1.2% of world resources), and 6.6 billion tons of coal (0.6% of global resources) (BP 2017). In February 2018, a new forecast (EIA 2018) of primary energy consumption was developed. The United States consumed 2.3 billion toe in 2016, or 17.1% of global consumption, which puts the country in second place after China, which consumed 3.0 billion toe (23.0% of global consumption) (BP 2017). Taking into account the abundant reference material, it was decided to use 2014 as the base year for the analysis and to limit the forecast period to 2040.

Forecasts until 2040

The forecasts for the United States are based on data from International Energy Agency (IEA) – World Energy Outlook 2017 (WEO 2017) and IHS Makrit reports (IHS 2015). Price

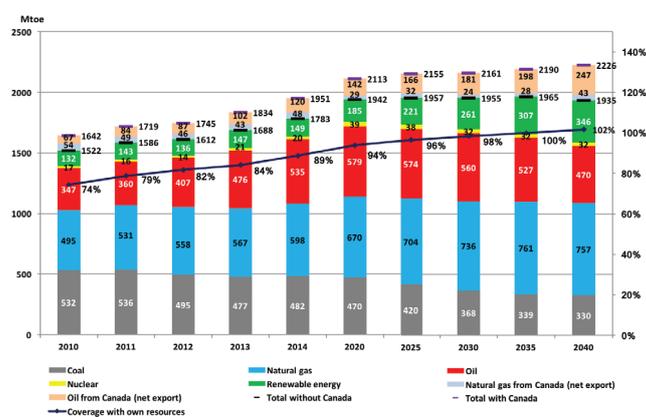
assumptions, resources, production, and consumption for WEO 2014 are presented in Table 1 and Table 2. The forecast applies to both the United States and Canada, as their economies are closely related.

Forecasts for the United States have remained virtually unchanged for two years (Olkuski et al. 2016); the baseline scenario assumes a minimum decrease in primary energy consumption to a level of 2190 Mtoe (a 1% decrease) by 2040. The current policy scenario assumes an increase to 2451 Mtoe (11%), while the environmental scenario assumes a decrease to 1958 Mtoe (11%). Changes in the structure of primary energy consumption (Fig. 1) are not as evident. All scenarios predict a decline in the share of oil consumption in the United States from the current level of 36% to 20–28%, depending on the variant in the year 2040. As a result, a decrease in the demand for oil (even by 400 Mtoe) can be expected; however, taking into account the current record-breaking US production, this scenario is unlikely. Coal is, and will continue to be, an important energy resource in all scenarios. In the baseline scenario, its role is increasing, while in the remaining scenarios, a slight decrease can be observed (except for the environmental scenario). It should be emphasized that there are no plans to completely move away from coal as an energy source. The use of nuclear power plants in the United States is also predicted in a similar way: in the baseline scenario – 240 Mtoe, in the ecological variant – 285 Mtoe, and in the current policy scenario – 220 Mtoe. The share of renewable energy in primary energy consumption increases to 16% in the baseline



Fig. 1. Forecast of the volume and structure of primary energy consumption in the USA in the analyzed scenarios of the International energy Agency. Source: Calculations of the Energy Studies Institute, Warsaw

Rys. 1. Prognozy wielkości i struktury konsumpcji energii pierwotnej w Stanach Zjednoczonych w analizowanych scenariuszach Międzynarodowej Agencji Energii



Caution: When it comes to nuclear energy, the equivalent of primary energy derived from the domestic nuclear fuel is presented.

Fig. 2. The extraction and production of primary energy carriers in the United States and Canada – the IEA baseline scenario. Source: Calculations of the Energy Studies Institute

Rys. 2. Wydobycie i produkcja nośników energii pierwotnej w Stanach Zjednoczonych i Kanadzie – wariant bazowy MAE

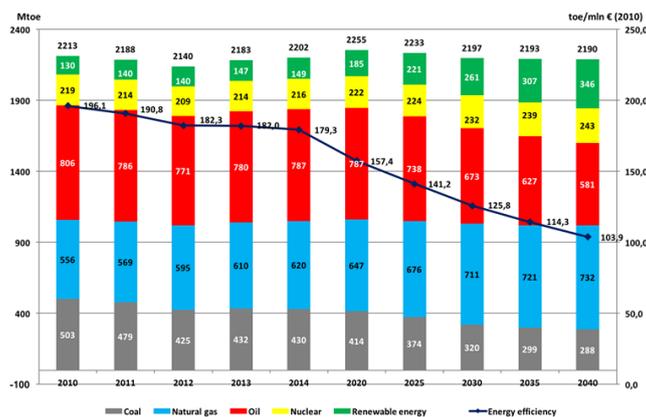


Fig. 3. The volume and structure of primary energy demand in the United States – the IEA baseline scenario. Source: Calculations of the Energy Studies Institute

Rys. 3. Wielkość i struktura zapotrzebowania na energię pierwotną w Stanach Zjednoczonych – wariant bazowy MAE

scenario, and up to 12% and above 28% in the continuation and proecological scenarios, respectively. Natural gas, whose consumption will increase to around 27–33%, will be the basic raw material (just like in the case of the EU) in all scenarios (except for the eco scenario). Such a high share of natural gas in power generation is a result of American success in

the production of gas from unconventional sources. The United States and Canada can export the production surplus (in the LNG form) to European Union countries (Sikora et al. 2018 a, b, c).

The United States is today one of the most hydrocarbon-rich countries; taking into account hydrocarbons in Can-

Tab. 1. Price assumptions for crude oil, natural gas, coal and CO₂ emissions as of 2014. Source: Calculations of the Energy Studies Institute based WEO (World Energy Outlook) 2014

Tab. 1. Założenia cenowe dla ropy naftowej, gazu ziemnego, węgla i emisji CO₂ – stan bazowy na 2014 r.

		New Policy				Current Policy			450 Scenario		
		2013	2020	2030	2040	2020	2030	2040	2020	2030	2040
(Real terms 2013)		106	112	123	132	116	139	155	105	102	100
Crude oil (Brent)	USD/bbl										
Natural gas											
United States	USD/MBtu	3,7	5,5	6,6	8,2	5,5	6,8	8,5	5,1	5,9	6,1
Europe (imports)	USD/MBtu	10,6	11,1	12,1	12,7	11,5	13,2	14	10,5	10	9,2
Japan (imports)	USD/MBtu	16,2	14,4	14,6	15,3	15	16,3	17,3	13,6	12,6	12,0
OECD steam coal imports)	USD/tonne	86	101	108	112	107	117	124	88	78	77
CO ₂ emissions	EUR/tonne	4,5	16,5	27,75	37,5	15	22,5	30	16,5	75	105

Tab. 2. Resources, production, and consumption of fossil fuels in the United States and Canada as of 2014

Tab. 2. Zasoby, wydobycie i konsumpcja paliw kopalnych w Stanach Zjednoczonych i Kanadzie – stan bazowy na 2014 r.

Parameter	The United States and Canada*			
	Oil	Natural gas	Coal	Total
Reserves [million toe]**	33 763	10 619	136 105	180 487
Production [million toe]	730	814	545	2 088
Consumption [million toe]	939	789	475	2 203
Reserves/Production	46,27	13,05	249,96	86,43
Reserves/Consumption	35,95	13,46	286,81	81,94
Production/Consumption	0,78	1,03	1,15	0,95

* in the case of the United States, Canadian reserves were added to US commodity reserves, assuming that both countries are reliable suppliers of economically available raw materials.

** The reserves include documented and proven resources in category P (90% probability)

Source: Calculations of the Energy Studies Institute based on BP Statistical Review of World Energy 2015-18 (BP 2017; 2018)

ada, the United States is one of the most self-sufficient countries in the world (not counting countries from the Persian Gulf). As of today, the coal resources of the United States will last for about 250 years of exploitation, while the proven gas reserves will last for another 13 years (up to 40). At the current level of exploitation, oil reserves (including Canada's resources) should last for around 35-40 years.

The energy security is the most important goal of the current US energy policy. The energy independence and low energy prices are the reason why the United States can compete with the European Union and Southeast Asia, including China. So precise and carefully thought out energy policy translates into small differences between scenarios (Fig. 1). It also means that deep changes in the US energy sector are neither wanted nor expected.

The IEA forecast in the baseline scenario (Fig. 2) assumes the development of production of raw materials, mainly natural gas, accompanied by the stabilization of oil production and a decrease in coal mining. The IEA predicts the development of renewable energy sources.

The economic potential of primary energy from renewable sources in the United States based on NREL (NREL, 2015) and IRENA (IRENA, 2015) ranges from 720 to 1230 Mtoe (for the EU, the absolute maximum is 1015 Mtoe) (Table 3). In the baseline version, bioenergy (dry biomass, biogas, and biofuels), accounts for 44%, solar power (photovoltaics (PV), the so-called CSPs (Concentrated solar power plants), and

solar collectors for thermal energy production) accounts for around 49%, while geothermal energy, both deep wells and heat pumps, is 2%. Wind energy is 3.5% of the total.

Analyzing the volume and structure of primary energy demand in the United States, it can be seen that, according to IEA, renewable energy sources will replace not only coal, but (to a lesser extent) also crude oil (Fig. 3). The consumption of oil and coal may decrease by about 206 Mtoe and 142 Mtoe, respectively; this is associated with an increase in the consumption of renewables and natural gas by 197 and 116 Mtoe, respectively. In this variant, the primary energy demand in the United States drops by 12 Mtoe (a 0.5% decrease compared to 2014).

The energy policy of the US is focused on the energy independence of the country, which is confirmed by the IEA in the forecast of net primary energy imports (Fig. 4). A decrease in imports to around 250 Mtoe (including Canadian raw materials) or 420 Mtoe (not including Canadian raw materials) is expected by the year 2040. It is also expected that the USA (already an exporter of coal) will be an exporter of natural gas by 2020. In addition, taking into account the Canadian oil deposits, the US could export around 100–140 Mtoe/year of natural gas from 2025 on.

Due to a decrease in coal mining activities, it is expected that the demand for coal in the United States will decrease by almost 50% (IEA, 2015) (IHS, 2015). Coal will be substituted by cheaper natural gas from unconventional deposits.

Tab. 3. The economic potential of RES in the United States, Mtoe. Source: Calculations of the Energy Studies Institute based on: NREL (2015); IRENA (2015); EIA (2015); IEA (2015)

Tab. 3. Potencjał ekonomiczny OZE w USA, Mtoe

Item	2013	2014	Economic potential and the reduction in value	The baseline economic potential	Technical potential	The use of the economic potential (min)	The use of the economic potential (max)
Biomass primary energy	97	98	475	542	2866	21%	18%
Wind power	15	16	89	42	1908	18%	38%
Hydropower	23	22	27	30	30	82%	76%
UPV	1	2	53	557	25578	2%	0%
DPV			26	18	134		
Solar energy - heat	6	8	23	23		33%	33%
Geothermal electricity production	1	1	15	11	20	10%	13%
Geothermal heat production	3	5	11	11		45%	45%
Tidal energy	-	-	-	-	-	-	-
Total RES	146	151	719	1233	30537	21%	12%
Including:							
Renewable energy - hydropower	23	22	27	30	30	82%	76%
Renewable energy - bioenergy	97	98	475	542	2866	21%	18%
RES - other	26	29	216	661	27641	13%	4%

Caution! The economic potential and the reduction in value refer to the variant with a decreasing generation capacity (wind power and industrial solar technology) associated with the increasing volume of power and avoided external costs (including CO₂ emission costs). The base potential refers to the avoided CO₂ emission costs.

UPV – utility scale PV, DPV – distributed photovoltaics (residential-roof-mounted photovoltaic systems)

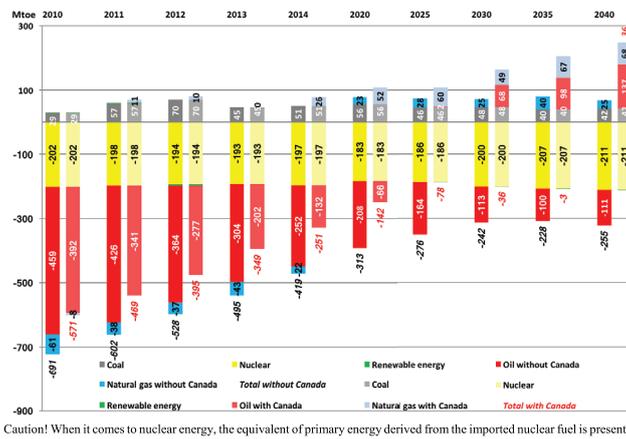
Despite the reduction in the production and consumption, the United States will still have significant resources of coal (50–55 Mtoe) that can be exported (Fig. 5). IHS predicts that coal exports to the Pacific market (Southeast Asia) and Atlantic market (Europe) will amount to 10–15 Mtoe/year and 37–38 Mtoe/year, respectively.

Naturally, coal will remain in the energy mix, but natural gas will play an increasingly important role. The IEA forecasts that the production of natural gas in the U.S. will increase to about 750–760 million tons of oil equivalent, which translates roughly to 30–40 million tons of exportable surplus. According to the IHS forecast of July 2015 (IHS, 2015), the gas production in the United States will increase to 950 Mtoe by 2030, and at the end of the forecast period it will grow up to 1050 Mtoe/year (Fig. 6). As a result, the United States already started to export gas in 2018 in order to ultimately reach the export target of 90–100 Mtoe.

Decommissioning of obsolete coal-fired units, together with an increase in natural gas production, translates into the development of electricity generation capacities based on gas fuel; a total capacity of almost 320 GW is expected (an increase by 66%). Gas consumption in the energy sector will

increase by 133% over 25 years (Fig. 7). A 14% increase in the demand for gas can also be observed in the industry sector. Meanwhile, the consumption in the commercial and household sector remains at the current level. In addition, the use of gas as a fuel for motor vehicles (mainly trucks) is also forecasted. As a result, according to IHS, the consumption of natural gas will increase to 960 Mtoe by 2040. Meanwhile, according to IEA, a lower increase (up to 732 Mtoe) is expected.

The industrial use of hydraulic fracturing for the exploitation of unconventional deposits has initiated the large scale extraction of natural gas. An indirect success of the shale gas boom was the extraction of tight oil and NGL (Natural Gas Liquids) including ethane, LPG, and natural gasoline, extracted during the exploitation of the so-called "wet" gas deposits (Figure 8). It should be noted that the US energy sector is the main beneficiary of the success of the shale revolution. The peak oil (for both crude oil and NGL) predicted by IHS, with a maximum rate of oil production of 750 Mtoe (approximately 220 Mtoe more than the current production), is to occur around 2025. The target production is to be lower and is expected to remain at 580 Mtoe; the IEA predicts the



Caution! When it comes to nuclear energy, the equivalent of primary energy derived from the imported nuclear fuel is presented.

Fig. 4. Net imports of primary energy carriers to the United States - the IEA baseline scenario. Source: Calculations of the Energy Studies Institute
Rys. 4. Import netto nośników energii pierwotnej do Stanów Zjednoczonych – wariant bazowy MAE

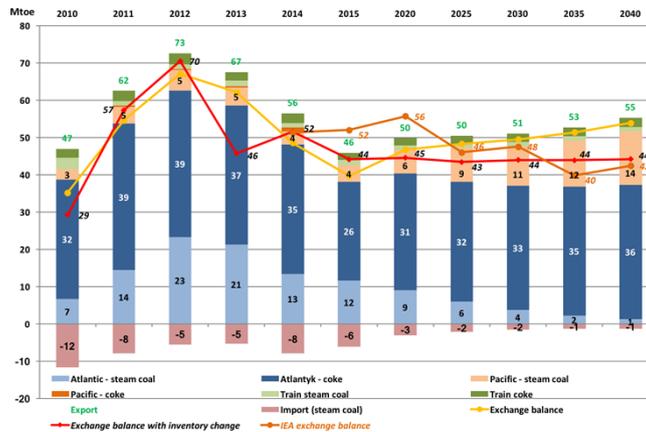


Fig. 5. Forecasts of net exports of coal (steam coal and coking coal) from the United States (IHS, 2015). Source: The Energy Studies Institute
Rys. 5. Prognozy eksportu netto węgla (energetycznego i koksującego) ze Stanów Zjednoczonych wg. IHS, 2015

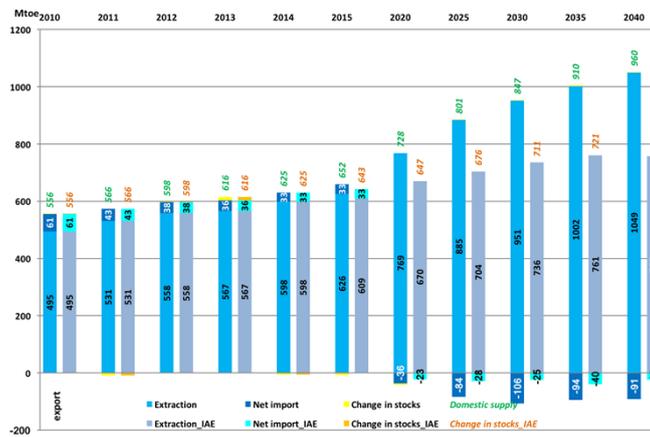


Fig. 6. The structure of natural gas supply in the United States (IHS, 2015). Source: The Energy Studies Institute
Rys. 6. Struktura podaży gazu ziemnego w Stanach Zjednoczonych wg. IHS, 2015

production level of 470 Mtoe. This is mainly due to the depletion of conventional deposits in the Gulf of Mexico.

According to IHS, an increase in crude oil and NGL consumption in the United States to a net level (that is including net exports) of around 810-820 Mtoe in 2025 and finally 714 Mtoe by 2040 is expected. In the case of the USA, this is a significant net export that reduces the total consumption (unlike in the EU, where low imports increase the total oil

consumption). According to IEA, the forecasted oil and NGL consumption amounts to 737 and 581 Mtoe, respectively (Fig. 9).

Currently, crude oil is imported to the United States from almost all over the world. Geographically, the nearest supplier is Canada, which guarantees about 36–37% of the total net oil imports; According to IHS, this level can rise up to 75% in 10 years.

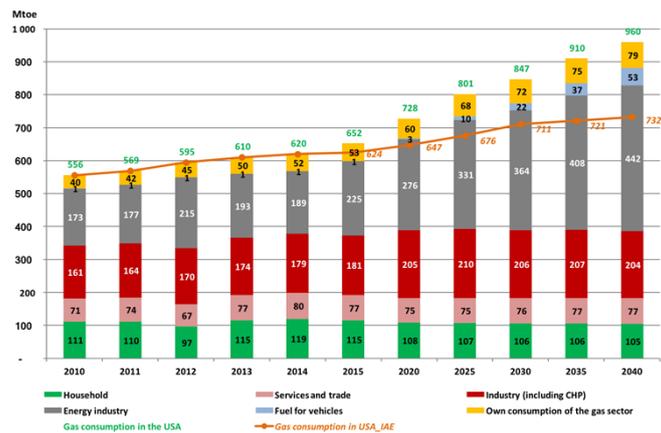


Fig. 7. The estimated natural gas consumption in the United States (IHS, 2015). Source: The Energy Studies Institute
 Rys. 7. Prognozy zużycia gazu ziemnego w Stanach Zjednoczonych wg. IHS, 2015

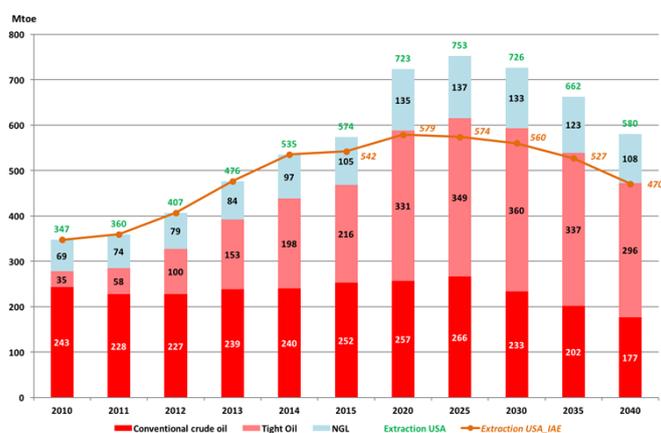
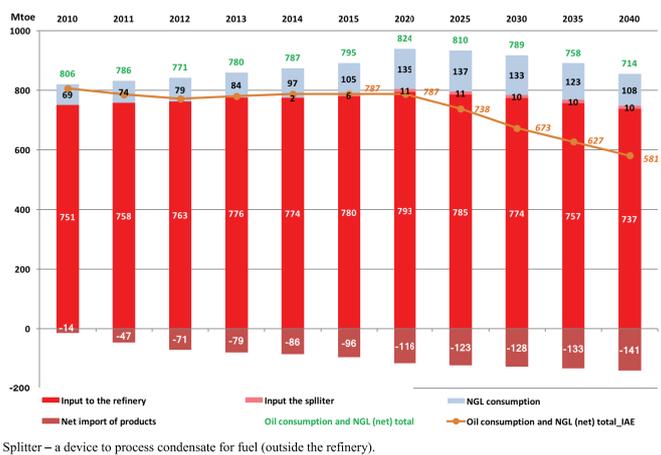


Fig. 8. The forecasted oil and NGL production in the United States (IHS, 2015). Source: The Energy Studies Institute
 Rys. 8. Prognozy wydobycia ropy naftowej i NGL w Stanach Zjednoczonych wg. IHS, 2015



Splitter – a device to process condensate for fuel (outside the refinery).

Fig. 9. The forecasted oil and NGL consumption in the United States (IHS, 2015). Source: The Energy Studies Institute
 Rys. 9. Prognozy konsumpcji ropy naftowej i NGL w Stanach Zjednoczonych wg. IHS, 2015

Based on the analysis of forecasts of consumption of petroleum products in the United States (Fig. 10), it can be stated that gasoline consumption drops from 375 Mtoe to 298 Mtoe, but it still remains the dominant petroleum product. In addition, a decrease in the consumption of middle distillates, mainly diesel, is clearly visible. The consumption increases only in the case of aviation fuel (including kerosene).

The result of the continued processing of crude oil and the reduction of consumption of petroleum products in the United States is the oversupply of products intended for export to various parts of the world, including the European Union (Fig. 11).

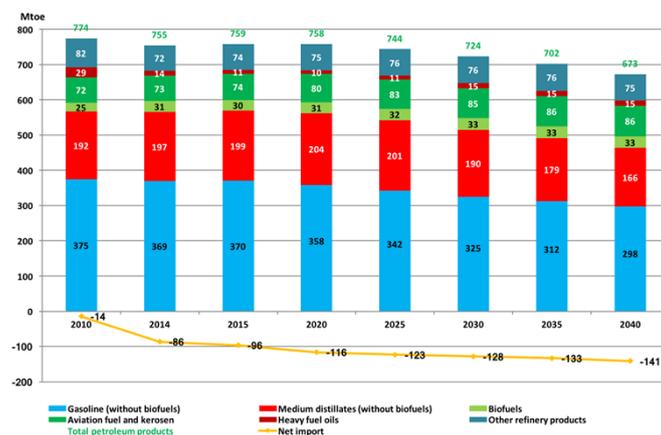


Fig. 10. Forecasts of petroleum products consumption in the United States. (IHS Markit). Source: The Energy Studies Institute
Rys. 10. Prognozy konsumpcji produktów ropopochodnych w Stanach Zjednoczonych wg. IHS Markit

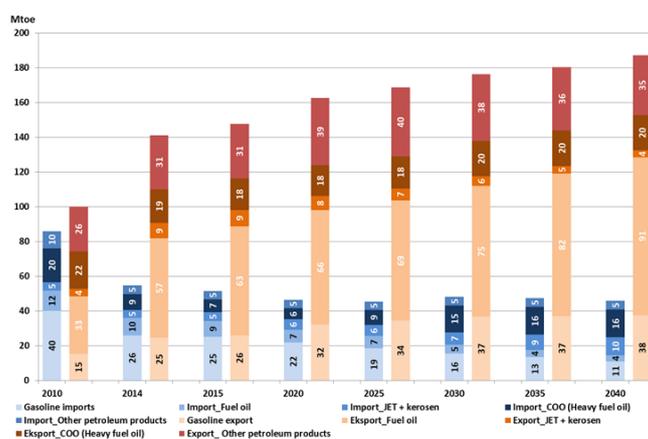


Fig. 11. A forecast of US imports and exports of major petroleum products (IHS, 2015). Source: The Energy Studies Institute
Rys. 11. Prognoza importu i eksportu głównych produktów ropopochodnych w Stanach Zjednoczonych wg. IHS, 2015

Conclusions

Based on the data presented above, the ongoing transformation in the United States is clearly visible. The country, which used to import significant amounts of energy resources, may become one of the major exporters of hydrocarbons, mainly: natural gas (LNG), crude oil (including derivative products), and bituminous coal (large-scale export of coal is already taking place). Such a change in the US economy would be very favorable for countries dependent on the import of raw materials. As a result, the United States, becoming an exporter of natural gas to Europe, would become a natural competitor for current suppliers of this hydrocarbon.

The analyses carried out have shown that the US policy puts a large emphasis on the energy security and self-sufficiency. As of today, the United States is one of the most hydrocarbon-rich countries, while low electricity prices are the reason why American products are competitive compared to products from the European Union and China. Reducing the use of coal in the U.S. economy in favor of renewable energy sources will result in an oversupply of this raw material in the international markets, which, in turn, will lead to a decrease in prices. The increasing production of oil and gas will have a similar effect.

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Literatura – References

1. BP 2017 - BP Statistical Review of World Energy, 2015-2018
2. WEO 2017 - WEO (World Energy Outlook) 2017
3. WEO 2014 - WEO (World Energy Outlook) 2014
4. NREL (2015) – „Estimating Renewable Energy Economic Potential in the United States: Methodology and Initial Results” (NREL „U.S. Renewable Energy Technical Potentials: A GIS-Based Analysis”, July 2012). National Renewable Energy Laboratory (NREL)
5. IRENA 2015 – „Renewable Energy Prospects: United States of America REmap 2030 analysis”. The International Renewable Energy Agency (IRENA)
6. EIA 2015 – Energy Information Administration (historical data)
7. EIA 2018 – Annual Energy Outlook 2018 with projections to 2050
8. IEA 2015 – International Energy Agency (historical data)
9. IHS 2015 – IHS Markit North American Gas Monthly Briefing, July 2015
10. Olkuski T., Sikora A., Sikora M., Szurlej A., Tora B., 2016 – Rynek gazu ziemnego w kontekście umowy TTIP (Natural gas market in context of transatlantic trade and investment partnership). Rynek Energii 5(126)/2016 October 2016: Rynek126/3 and CIRE: http://www.cire.pl/pokaz-pdf-%252Fpliki%252F2%252F2016%252Frynek_gazu_ziemnego_w_kontekscie_umowy_ttip.pdf
11. Sikora A., Sikora M., 2018a – LNG, czy to się opłaca? <https://www.cire.pl/item,158057,13,0,0,0,0,lng-czy-to-sie-oplaca.html>; 2.02.2018 and Biznes Alert: <http://biznesalert.pl/sikora-lng-ko-szty-analiza/>; 2.02.2018
12. Sikora A., Sikora M., 2018b – Urynkowanie (commoditization) LNG. <https://www.cire.pl/item,158785,13,0,0,0,0,0,urynkowanie-commoditization-lng.html>; 19.02.2018, and Urynkowanie LNG (ANALIZA) <https://biznesalert.pl/urynkowanie-lng-analiza/>; 21.02.2018
13. Sikora A., Sikora M., 2018c – Ubu Roi ou les Polonais/Ubu Król, czyli Polacy. <https://www.cire.pl/item,159364,13,0,0,0,0,0,ubu-roi-ou-les-polonaisubu-krol-czyli-polacy.html>; 1.03.2018, and „Ubu Król, czyli Polacy (ANALIZA)”, <http://biznesalert.pl/rynek-lng-analiza/>; 1.03.2018

Prognozy wydobycia, konsumpcji i salda wymiany energii pierwotnej oraz paliw w USA i Kanadzie

W artykule przeprowadzono analizę różnych prognoz wydobycia, konsumpcji i salda wymiany energii pierwotnej oraz paliw wtórnych w Stanach Zjednoczonych oraz częściowo w Kanadzie. Analiza łączna gospodarek Stanów Zjednoczonych i Kanady jest jak najbardziej uzasadniona, gdyż gospodarki te są ze sobą ściśle powiązane. Analiza obejmuje różne scenariusze zapotrzebowania na paliwa i energię, od scenariusza bazowego realizowanego do tej pory, poprzez scenariusz nowych polityk zakładający, że kraje stosują się do ustalonych na szczeblu krajowym pułapów emisji, zadeklarowanych po COP21 w Paryżu, aż do scenariusza ekologicznego, najbardziej restrykcyjnego pod względem ochrony środowiska i zakładającego nie przekraczanie temperatury na Ziemi o więcej 2°C w stosunku do ery przedindustrialnej. Oczywiście w każdym ze scenariuszy analizowane wielkości są różne co przedstawiono na rysunkach. Najwięcej uwagi poświęcono surowcom kopalnym, czyli ropie naftowej, gazowi ziemnemu i węglowi zarówno kamiennemu jak i brunatnemu. Przedstawiono prognozy wydobycia, zużycia, a także importu poszczególnych nośników. Pokazano, że amerykańska polityka ogromny nacisk kładzie na bezpieczeństwo energetyczne i samowystarczalność energetyczną. Stany Zjednoczone to dzisiaj jeden z najbardziej zasobnych w węglowodory krajów, a niskie ceny energii sprawiają, że amerykańskie produkty są konkurencyjne w stosunku do produktów z Unii Europejskiej a nawet Chin. Ograniczanie wykorzystywania węgla w gospodarce amerykańskiej na rzecz odnawialnych źródeł energii spowoduje pojawienie się większych ilości tego surowca na rynkach międzynarodowych, co doprowadzi do spadku cen. Również wzrastająca produkcja ropy naftowej i gazu będzie miała podobny skutek.

Słowa kluczowe: prognozy, wydobycie, zużycie, energia pierwotna, paliwa wtórne